



National and 50-State Population Projection Methodology

This document describes in detail the steps in developing population projections for the nation, the 50-states, and the District of Columbia for 2030, 2040, and 2050. The projections include:

- Total population
- By age group (18 age cohorts at 5-year intervals: 0-4, 5-9, 10-14 ... 80-84, and 85+)
- By sex (within each age group)

This vintage is benchmarked on the 2020 Decennial Census Count data; and uses a combination of exponential growth and linear extrapolation methods in conjunction with the Hamilton-Perry approach, which is a reduced form of the cohort-component method. The system is internally consistent with detailed national projections held equal to the sum of the individual characteristics across the 50-states and D.C.; and within the subset of each state projection series, age is controlled to the state totals, and sex is controlled to each age group.

Input Data:

U.S., 50-states, and D.C. population for

- 2000 (1 April count) – by 18 age cohorts
- 2010 (1 April count) – by 18 age cohorts
- 2020 (1 April count) – by 18 age cohorts, divided into male, female, and total

Total Population Projections:

Approach for projecting 2030 total population:

- With 2020 as the launch year, we create two different scenarios based on exponential growth and linear extrapolation. The average of both yields the final projected ***StatePopulation***₂₀₃₀.

- Scenario I applies exponential population growth rate using data from 2010 and 2020
- Scenario II applies half of the absolute population change between 2010 and 2020
- The projected U.S. population for 2030 is set to the sum of the state populations. This is the final national level population projection for 2030.

$$USPopulation_{2030} = \sum_{States} StatePopulation_{2030}$$

Approach for projecting 2040 and 2050 total population:

- Using age distribution data from 2000, 2010, and 2020, we generate CPRs (child population ratio) and CCRs (cohort change ratio) for every age cohort of the U.S. population, to apply the Hamilton-Perry cohort-component method.

For cohorts 0-4 and 5-9, CPRs capture the birth rates in the prior decades. We divide the child population by the appropriate population of child-bearing age to generate the CPRs.

$$CPR_{0-4}^{2000-2010} = \frac{USPopulation_{0-4}^{2010}}{USPopulation_{15-44}^{2010}} \quad \& \quad CPR_{0-4}^{2010-2020} = \frac{USPopulation_{0-4}^{2020}}{USPopulation_{15-44}^{2020}}$$

$$CPR_{5-9}^{2000-2010} = \frac{USPopulation_{5-9}^{2010}}{USPopulation_{20-49}^{2010}} \quad \& \quad CPR_{5-9}^{2010-2020} = \frac{USPopulation_{5-9}^{2020}}{USPopulation_{20-49}^{2020}}$$

For cohorts 10-14, 80-84, 85+, CCRs measure the combined effects of deaths and migration. We use the ratio of population in an age group (a) in one decade, to the population in age group ($a-10$) in the previous decade, to calculate CCRs.

$$CCR_{Age Cohort}^{2000-2010} = \frac{USPopulation_{Age Cohort}^{2010}}{USPopulation_{Age Cohort-10}^{2000}} \quad \& \quad CCR_{Age Cohort}^{2010-2020} = \frac{USPopulation_{Age Cohort}^{2020}}{USPopulation_{Age Cohort-10}^{2010}}$$

To smooth out fluctuations, we use averaged CCR and CPR values over 2000-2010 and 2010-2020.

$$\overline{CPR}_{Age Cohort} = \frac{CPR_{Age Cohort}^{2000-2010} + CPR_{Age Cohort}^{2010-2020}}{2} \quad \& \quad \overline{CCR}_{Age Cohort} = \frac{CCR_{Age Cohort}^{2000-2010} + CCR_{Age Cohort}^{2010-2020}}{2}$$

- The projected age-specific 2030 Hamilton-Perry U.S. population is calculated by aging forward the 2020 cohorts using the averaged CPRs and CCRs. For example:

$$USPopulation_{Age Cohort}^{HP2030} \cong \overline{CCR}_{Age Cohort} * USPopulation_{Age Cohort-10}^{2020}$$

- The projected total 2030 Hamilton-Perry U.S. population can then be calculated by summing across all age cohorts

$$USPopulationHP_{2030} = \sum_{Age\ Cohorts} USPopulationHP_{Age\ Cohort}^{2030}$$

- We then construct the projected age-specific 2030 U.S. population for each age interval, by redistributing the projected total 2030 U.S. population as per Hamilton-Perry age distribution.

$$USPopulation_{Age\ Cohort}^{2030} = \frac{USPopulationHP_{Age\ Cohort}^{2030}}{USPopulationHP_{2030}} * USPopulation_{2030}$$

- The projected age-specific 2040 Hamilton-Perry U.S. population is calculated by aging forward the 2030 cohorts using the averaged CPRs and CCRs. For example:

$$USPopulationHP_{Age\ Cohort}^{2040} \cong \overline{CCR}_{Age\ Cohort} * USPopulation_{Age\ Cohort-10}^{2030}$$

- The projected total 2040 Hamilton-Perry U.S. population can then be calculated by summing across all age cohorts

$$USPopulationHP_{2040} = \sum_{Age\ Cohorts} USPopulationHP_{Age\ Cohort}^{2040}$$

- Next the projected age-specific 2040 U.S. population for each age interval is set to the projected age-specific 2040 Hamilton-Perry U.S. population

$$USPopulation_{Age\ Cohort}^{2040} = USPopulationHP_{Age\ Cohort}^{2040}$$

- Finally, the projected total 2040 U.S. population are set to the Hamilton-Perry level for 2040

$$USPopulation_{2040} = USPopulationHP_{2040}$$

- Now the projected state population for 2030 from exponential growth can be calculated using the exponential population growth rate using data from 2010 and 2020

$$StatePopulationExp_{2040} = StatePopulation_{2030} * e^{r*10}$$

- The final projected state population for 2040 can be calculated by raking the exponential growth state population to the projected national total for 2040

$$StatePopulation_{2040} = \frac{StatePopulationExp_{2040}}{\sum_{States} StatePopulationExp_{2040}} * USPopulation_{2040}$$

- The 2050 projections (*USPopulation*₂₀₅₀ & *StatePopulation*₂₀₅₀) are generated using the same approach and repeating the previous process.

Population Projections by Age:

For projecting the population by age, first we create state-specific average CPRs and CCRs using the age distribution data from 2000, 2010, and 2020, for every age cohort, to apply the Hamilton-Perry cohort-component method. In order to get the projected population by age for 2030 for the 50-states and D.C., these state-specific average CPRs and CCRs are applied to age forward the 2020 population for each state. This generates the proper Hamilton-Perry age distribution for 2030 within each state. To accommodate the expected age structure, each of the 65+ cohorts are set according to their Hamilton-Perry levels for 2030. The remaining age groups are then redistributed as per their Hamilton-Perry shares in the residual from the state total population for 2030 calculated earlier. For the U.S. as a whole, population in each age cohort can be calculated by summing the population belonging to the corresponding age group, across all the states.

This process is repeated for 2040 and 2050 by applying the Hamilton-Perry age forwarding to the state population in the immediately preceding decade, and using this age distribution to redistribute the previously calculated state total projections. The national projected population by age for 2040 and 2050 is similarly calculated by summing over the projected age categories across all the states.

Population Projections by Sex:

Projections by age and sex are determined by maintaining the population's age-specific sex-ratio as per the 2020 Census. This sex-ratio is applied to the projected population in each of the 18 age cohorts within each of the 50-states and D.C., for 2030, 2040 and 2050, ensuring all subcategories are controlled to the state population projections. The male and female population groups within each age cohort are then summed across all the states, to get the U.S. population projections by sex.